

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in charge]

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In December a total of 497 airplane and radiosonde upper-air observations were made in the United States. The mean free-air data based on these observations are shown in tables 1 and 1a, and include pressure (P), temperature ($^{\circ}$ C.), and relative humidity (R. H.), recorded at certain standard geometric heights. During the month 78 radiosonde observations were taken at 17 kilometers over the six stations listed in table 1a. This represented 42 percent of all observations launched at the surface. The "means" are omitted from the tables whenever less than 15 observations are made at the surface and less than 5 at a standard height, but 15 observations are necessary for those levels that fall within the limits of the monthly vertical range of the tropopause.

Chart I shows the departure of mean surface temperatures ($^{\circ}$ F.) from normal. The weather over most of the United States was warmer than normal, and decidedly above in the regions west of the Mississippi River valley. Over the northern Rocky Mountain region the mean temperatures were as much as 7° F. above their normals for December. Temperatures also were moderately high, ranging from 2° F. to 4° F. over New England and portions of the lower Lakes region. But departures from the mean temperature were very slight over the Southeast, being 1° F. to 2° F. below normal in the east Gulf States. Temperatures along the north Pacific coast were about normal in December.

Mean free-air temperatures ($^{\circ}$ C.), recorded above the surface, are given in tables 1 and 1a. During December the lowest mean temperatures at the surface and 0.5 kilometer, respectively (-10.2° C. and -8.6° C.), were recorded over Fargo, N. Dak. But at all other levels, up to and including 7 kilometers, the lowest mean temperatures (-8.7° C., -10.6° C., -12.1° C., -13.7° C., -15.4° C., -20.7° C., -26.8° C., -32.7° C., and -39.8° C., respectively), occurred over Sault Ste. Marie, Mich. At 8, 9, and 10 kilometers, however, Fargo, N. Dak., again became the coldest station (-47.1° C., -52.8° C., and -54.9° C., respectively). The lowest temperatures at 11 and 12 kilometers were found over Omaha, Nebr. (-55.4° C.), and Oakland, Calif. (-57.1° C.), respectively. Above 12 kilometers the lowest temperatures were reported over Oklahoma City, Okla., being -56.6° C., -59.0° C., -61.3° C., -63.6° C., -67.2° C., and -68.4° C., respectively, at 12, 13, 14, 15, 16, and 17 kilometers. However, in these same levels—from 12 to 17 kilometers, inclusive—higher temperatures than elsewhere were recorded over Fargo, N. Dak., and Sault Ste. Marie, Mich. At Omaha, Nebr., where a maximum altitude of 20 kilometers was reached by radiosonde, a slight increase in mean temperature (-63.8° C., -63.5° C., -62.9° C., and -62.2° C., respectively) was noted at 17, 18, 19, and 20 kilometers.

December was seasonally colder than the preceding month of November at nearly all stations. But exceptions occurred at Oakland, Calif., San Diego, Calif., and El Paso, Tex., where the December means were slightly higher than in November at the lower levels, while at Salt Lake City, Utah, and Billings, Mont., temperatures were somewhat higher at all levels. Spokane, Wash., was warmer than November only at 2, 2.5, and 3 kilometers. The highest mean temperatures for December occurred over Oakland, Calif., in the lower levels up to 2.5 kilometers. But above that level, up to 5 kilometers, inclu-

sive, the highest temperatures were recorded over Pensacola, Fla. Mean free-air temperatures for the country as a whole were very slightly higher than those noted during the other winter months of January and February 1938, while over the South they were actually lower at all levels above 2.5 kilometers.

During December the mean atmospheric pressures over the United States were well distributed in the upper air, and definitely located a statistical low-pressure center over Sault Ste. Marie, Mich., at all levels. Pressure was highest over the southern States, and extended from Pensacola, Fla., to the Pacific coast (San Diego, Calif.) and thence northward to Oakland, Calif. The mean pressures over Pensacola, Fla., slightly exceeded those recorded elsewhere in this belt of high pressure. At each level the differences between the low pressure area located over Sault Ste. Marie, Mich., and the high pressures centered over Pensacola, Fla., were found to increase steadily with altitude. For example, these differences in millibars, were: 12, 15, 17, 20, 21, 23, 25, and 26, at 0.5, 1, 1.5, 2, 2.5, 3, 4, and 5 kilometers, respectively. December mean pressures were found to be slightly lower than those for November at most stations. Also, the mean low pressures that were recorded in December at 0.5, 1, 4, and 5 kilometers were less than those noted in any month of the year and second only to the lowest means for the year which were recorded in January 1938 at 1.5, 2, 2.5, and 3 kilometers.

The mean relative humidity for December was somewhat higher generally than during the previous month. This situation was observed over the entire country at all levels, except in the South over Pensacola, Fla., and over the northern Rocky Mountain region at Billings, Mont. The highest humidity at all levels occurred over Sault Ste. Marie, Mich., where barometric pressures and mean temperatures were lowest. Relative humidity ranged from a mean of 91 percent at 0.5 kilometer to 69 percent at 5 kilometers, and 65 percent at 7 kilometers over Sault Ste. Marie, Mich. Since the temperature at 7 kilometers fell below -40.0° C. no additional humidity data are available. The lowest mean humidities prevailed over El Paso, Tex., at the surface and 1.5 kilometers, and then over Pensacola, Fla., at all other levels, becoming 15 percent at 5 kilometers. A tendency toward high humidity was noted over the central Rocky Mountain region, particularly at Salt Lake City, Utah, for all levels.

Table 2 shows free-air resultant wind directions and velocities based on pilot-balloon observations made near 5 a. m. (75th meridian time) during December. Resultant wind directions were nearly normal over all stations making such observations, with the exception of those on the Pacific coast and, to a much lesser extent, in the Southeast. The current resultant wind directions at San Diego, Calif., and Medford, Oreg., showed abnormal departures at all levels. Resultant wind velocities remained about normal at many stations, but a few showed considerable variation. Velocity departures, as a rule, were positive, or greater than normal, while directional departures were about equally divided between orientations that were clockwise and counterclockwise with respect to normal.

Departures of current resultant wind directions from their normal at the surface were remarkably small. Surface variations, as a rule, are rather large, but during December the average of all surface departures was less

than in any other month of 1938. The outstanding exception to this situation existed at Sault Ste. Marie, Mich., where the difference of 105° was oriented counterclockwise with respect to the normal direction. Above the surface, the greatest average departure of any level was 24° at 1.5 kilometers, and the least was 10° at 5 kilometers. But, disregarding the abnormal directions on the Pacific coast, the average departure for each level in December was more uniform—about 10° .

Resultant winds during December were unusual along the Pacific coast. The two outstanding stations for the month, San Diego, Calif., and Medford, Oreg., showed the largest departures recorded at any station during 1938. A midway point, Oakland, Calif., was the third outstanding station during December. But farther north, at Seattle, Wash., directional departures were slight, being less than in any month of the year except January and April 1938. The only other pilot-balloon stations showing departures in direction worthy of note were Key West, Fla., and Pensacola, Fla. The directions at Pensacola, Fla., however, held closer to the normal resultant in December than during any month of 1938, while a similar condition existed at Key West, Fla., except for the months of May, June, and August 1938.

The December resultant wind directions at San Diego, Calif., were: 20° , 119° , 69° , 167° , 96° , 42° , 23° , 360° , and 323° as compared with the normal directions of 49° , 13° , 352° , 328° , 328° , 315° , 319° , and 311° at the surface, and 0.5, 1, 1.5, 2, 2.5, 3, 4, and 5 kilometers, respectively. Slightly smaller variations occurred at Medford, Oreg., and there the directions were: 98° , 31° , 135° , 154° , 166° , 174° , 168° , and 98° , as compared to the normals of 143° , 144° , 163° , 212° , 228° , 237° , 253° , and 261° at the surface, and 0.5, 1, 1.5, 2, 2.5, 3, and 4 kilometers, respectively. At Oakland, Calif., the December directions were: 73° , 47° , 39° , 33° , 25° , 344° , 333° , and 310° , as compared to the normals of 94° , 47° , 15° , 320° , 320° , 313° , 308° , and 284° at the surface, and 0.5, 1, 1.5, 2, 2.5, 3, and 4 kilometers, respectively.

Wind directions at all levels were nearly normal at Brooklyn, N. Y., Cheyenne, Wyo., Albuquerque, N. Mex., Billings, Mont., Fargo, N. Dak., Atlanta, Ga., Chicago, Ill., Cincinnati, Ohio, Nashville, Tenn., and St. Louis, Mo. At Spokane, Wash., and Oklahoma City, Okla., the wind directions were oriented in a clockwise rotation from normal at all levels; and at San Diego and Oakland, Calif., Billings, Mont., and Cheyenne, Wyo., for all levels except the surface. Medford, Oreg., Sault Ste. Marie, Mich., Chicago, Ill., and Cincinnati, Ohio, reported current winds that departed counterclockwise from normal at all levels.

The wind directions for December showed that westerly components prevailed at all stations for all levels above 2 kilometers, except at San Diego, Calif., and Medford, Oreg. Westerly resultant directions occurred in 71 percent of the observations at the surface, 73 percent at 0.5 kilometer, 80 percent at 1 kilometer, 83 percent at 1.5 kilometers, and 100 percent at 2, 2.5, 3, 4, and 5 kilometers,

inclusive. Most of the westerly winds fell within the northwest quadrant, and this condition became more pronounced with altitude, for, at 2 kilometers, 70 percent of the resultants had northwest components, 85 percent at 2.5 kilometers, 91 percent at 3 kilometers, 94 percent at 4 kilometers, and 100 percent at 5 kilometers.

Resultant wind velocities for December were not as high, on the whole, as in the preceding month of November. Departures from normal velocities were mostly negative, or less than normal, at San Diego, Calif., and Medford, Oreg., where large and unusual departures in direction have been noted. At Medford, Oreg., the velocities were less than normal by 0.1, 0.5, 1.0, 0.8, 0.9, 1.2, and 0.1 meters per second, at the surface, and 0.5, 1, 2, 2.5, 3, and 4 kilometers, respectively, and greater than normal by 0.8 meters per second at 1.5 kilometers. At San Diego, Calif., the velocities also were less than normal by 0.8, 0.6, 1.3, 1.6, 1.9, 1.4, and 0.4 meters per second at the surface, and 1.5, 2, 2.5, 3, 4, and 5 kilometers, and greater than normal by 0.4 and 0.2 meters per second at 0.5 and 1 kilometers, respectively. The December velocities at Oakland, Calif., were greater than normal at all levels by small amounts. In connection with the abnormal conditions that prevailed on the Pacific coast in December it should be noted that the normal resultant velocities for the month are lower in that section than elsewhere over the United States, except at Key West and Pensacola, Fla.

Resultant wind velocities that were nearly normal occurred at Houston, Texas, St. Louis, Mo., Cincinnati, Ohio, Atlanta, Ga., and Boston, Mass. Directional departures at these places also were insignificant. But, at Sault Ste. Marie, Mich., Seattle, Wash., Oklahoma City, Okla., and Billings, Mont., the December average velocity departures were largest for the country. High positive velocity departures were recorded in the 4- and 5-kilometer levels over Cheyenne, Wyo., Nashville, Tenn. ($+4.5$ m. p. s. at 4 kilometers), Omaha, Nebr., and Oklahoma City, Okla., and the largest negative departures occurred over Spokane, Wash., and Seattle, Wash. (-4.3 m. p. s.), at 4 kilometers.

Table 3 shows the maximum wind velocities recorded over the country during December. As in November, high velocities in the upper air were noted, but none that were so excessive. However, no velocities recorded between the surface and 2.5 kilometers equalled those reported during the previous months of 1938, but between 2.5 and 5 kilometers the velocities of 47.5 and 50 meters per second, respectively, at Charleston, S. C., and Springfield, Ill., were the highest recorded in those sections during 1938. Above 5 kilometers the velocities of 53.2, 76.8, and 68.0 meters per second, respectively, at Nashville, Tenn., Wichita, Kans., and Oklahoma City, Okla., were the highest reported from those sections in 1938. And the highest velocity reported in December, 78.8 meters per second from the North at 10 kilometers elevation of the 7th at Albuquerque, N. Mex., is a record wind speed at that place.

TABLE 1.—Mean free-air barometric pressures (*P*) in mb., temperatures (*T*) in °C., and relative humidities (*R. H.*) in percent obtained by air-planes during December 1938

Stations and elevations in meters above sea level	Altitude (meters) m. s. l.																												
	Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000				
	Number of obs.	P	T	R H	P	T	R H	P	T	R H	P	T	R H	P	T	R H	P	T	R H	P	T	R H	P	T	R H	P	T	R	
Billings, Mont. (1090 m)-----	31	891	-2.5	59	---	---	---	---	---	---	846	-0.1	53	795	-1.5	51	746	-4.9	52	700	-8.2	53	614	-13.8	52	538	-19.9	50	
Cheyenne, Wyo. (1873 m)-----	30	810	-4.4	68	---	---	---	---	---	---	---	---	---	---	---	---	60	748	-3.4	54	702	-5.7	52	617	-11.7	50	540	-18.9	48
Chicago, Ill. (187 m)-----	31	995	-3.6	82	956	-3.8	81	898	-4.5	73	842	-4.7	62	790	-5.9	58	741	-7.8	57	695	-10.5	58	609	-15.9	59	533	-22.0	58	
Coco Solo, C. Z. ¹ (15 m)-----	22	1010	25.0	85	956	23.0	82	903	20.2	83	852	17.4	78	803	14.8	72	756	12.7	68	713	10.4	58	631	5.3	56	559	3.3	43	
El Paso, Tex. (1193 m)-----	31	884	3.7	50	---	---	---	---	---	---	---	---	---	---	---	---	41	754	4.1	42	709	1.3	43	625	-4.6	36	550	-10.7	31
Lakehurst, N. J. ¹ (39 m)-----	26	1014	-0.9	84	957	-0.3	72	899	-2.9	66	844	-3.3	62	792	-4.8	57	743	-6.6	51	697	-9.0	49	612	-14.6	48	---	---	---	
Norfolk, Va. ¹ (10 m)-----	16	1023	3.2	85	963	3.6	80	905	2.1	71	850	1.8	65	799	-0.4	62	751	-1.6	61	705	-3.9	57	620	-10.2	52	544	-17.8	51	
Pearl Harbor, T. H. ¹ (6 m)-----	31	1016	21.5	79	960	21.0	76	906	17.8	80	854	15.6	77	805	14.2	60	758	12.8	47	715	11.0	38	633	6.6	27	560	0.9	25	
Pensacola, Fla. ¹ (13 m)-----	23	1022	5.8	90	964	10.3	61	908	8.8	60	854	7.6	53	804	5.7	49	755	4.3	39	710	2.3	30	626	-3.5	22	551	-9.8	15	
St. Thomas, V. I. ¹ (8 m)-----	31	1015	25.5	80	960	22.4	87	906	19.6	84	855	16.6	82	806	14.4	74	759	12.7	60	715	10.5	50	634	5.4	41	561	...	30	
Salt Lake City, Utah (1288 m)-----	31	876	-0.9	87	---	---	---	---	---	---	---	---	---	---	---	---	71	752	-3.5	72	706	-6.1	71	621	-10.5	60	544	-16.8	55
San Diego, Calif. ¹ (10 m)-----	31	1017	10.7	86	959	14.0	75	904	12.7	65	851	10.0	61	802	7.5	56	754	4.9	53	708	2.0	51	625	-4.2	46	551	-11.6	43	
Spokane, Wash. (597 m)-----	31	949	-1.5	87	---	---	---	---	---	---	848	-1.8	73	796	-3.3	68	747	-5.5	63	701	-8.3	64	616	-13.9	59	538	-20.0	59	

¹ Navy.

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

TABLE 1a.—Mean free-air barometric pressures (*P*) in mb., temperatures (*T*) in °C., and relative humidities (*R. H.*) in percent obtained by radiosonde during December 1938.

Altitude (meters) m. s. l.	Stations and elevations in meters above sea level																											
	Fargo, N. Dak. (274 m)				Nashville, Tenn. (180 m)				Oakland, Calif. (2 m)				Oklahoma City, Okla. (391 m)				Omaha, Nebr. (300 m)				Sault Ste. Marie, Mich. (221 m)				Washington, D. C. ¹ (13 m)			
	Number of obs.	P	T	R H	Number of obs.	P	T	R H	Number of obs.	P	T	R H	Number of obs.	P	T	R H	Number of obs.	P	T	R H	Number of obs.	P	T	R H	Number of obs.	P	T	R H
Surface.....	31	983	-10.2	90	31	999	2.7	76	31	1,020	8.2	87	31	973	1.8	69	31	982	-3.4	79	31	986	-5.0	90	30	1,019	1.2	78
500.....	31	954	-8.6	87	31	960	3.1	68	31	961	9.8	74	31	959	4.1	66	31	958	-2.8	70	31	952	-6.2	91	30	959	0.7	66
1,000.....	31	895	-7.5	81	31	902	1.6	68	31	905	9.4	66	31	902	4.9	56	31	899	-2.0	62	31	893	-8.7	93	30	901	-1.3	67
1,500.....	31	839	-8.3	75	31	848	0.7	58	31	852	7.7	62	31	849	4.1	51	31	845	-2.7	58	31	837	-10.6	90	30	846	-1.8	67
2,000.....	31	787	-9.5	71	31	797	-0.3	56	30	801	5.7	58	30	798	2.6	47	31	792	-4.2	56	31	784	-12.1	83	30	794	-3.2	62
2,500.....	31	737	-11.7	68	30	748	-1.9	54	30	754	3.2	54	30	750	0.6	45	31	744	-6.6	54	31	734	-13.7	78	30	745	-4.8	60
3,000.....	31	690	-13.9	65	30	702	-3.9	50	30	708	0.3	51	30	704	-1.3	44	31	697	-9.1	53	31	687	-15.4	74	30	699	-6.7	58
4,000.....	31	604	-19.1	63	30	618	-8.4	44	30	625	-6.0	47	30	620	-7.3	43	31	612	-14.5	51	31	601	-20.7	71	30	614	-11.1	53
5,000.....	31	528	-25.3	63	30	543	-14.9	41	30	549	-12.3	45	30	545	-13.4	42	30	536	-20.9	52	31	524	-26.8	69	30	538	-17.3	52
6,000.....	31	458	-31.9	61	30	475	-21.9	40	29	481	-19.3	45	30	477	-20.8	41	30	467	-27.6	51	31	456	-32.7	66	29	471	-23.4	54
7,000.....	31	398	-39.3	60	30	414	-29.1	36	29	420	-26.5	45	30	416	-27.8	40	30	405	-34.8	50	31	394	-39.8	65	29	410	-29.6	54
8,000.....	31	343	-47.1	---	30	359	-36.5	38	29	365	-34.3	44	28	361	-35.1	38	29	350	-42.1	---	30	340	-46.3	---	28	355	-36.0	---
9,000.....	28	294	-52.8	---	29	310	-42.9	---	29	315	-42.1	44	28	312	-42.1	39	29	302	-48.7	---	29	292	-51.2	---	27	307	-42.0	---
10,000.....	28	251	-54.9	---	29	267	-49.0	---	28	272	-48.6	---	27	268	-48.6	---	28	258	-53.4	---	29	250	-52.1	---	23	265	-48.0	---
11,000.....	27	215	-54.7	---	29	229	-53.2	---	27	233	-53.4	---	27	230	-53.6	---	28	221	-55.4	---	27	215	-51.1	---	21	227	-52.5	---
12,000.....	24	184	-53.7	---	27	196	-55.5	---	25	199	-57.1	---	26	197	-56.6	---	28	189	-56.0	---	26	184	-50.7	---	16	195	-55.2	---
13,000.....	23	157	-54.0	---	27	167	-57.1	---	25	170	-58.7	---	24	168	-59.0	---	27	161	-57.0	---	25	157	-51.6	---	15	166	-56.7	---
14,000.....	19	134	-54.5	---	23	142	-59.9	---	24	144	-60.0	---	20	143	-61.3	---	26	138	-58.6	---	23	135	-53.3	---	10	142	-58.5	---
15,000.....	15	114	-56.1	---	22	121	-62.2	---	23	123	-61.6	---	15	122	-63.6	---	26	117	-60.9	---	19	115	-54.6	---	9	121	-61.0	---
16,000.....	11	97	-57.0	---	17	103	-63.6	---	21	105	-62.7	---	10	103	-67.2	---	25	100	-62.5	---	14	98	-55.6	---	8	103	-62.9	---
17,000.....	6	83	-58.2	---	13	88	-64.0	---	18	89	-62.7	---	6	88	-68.4	---	22	84	-63.8	---	7	84	-56.7	---	6	87	-64.8	---
18,000.....	---	---	---	---	6	74	-64.6	---	13	76	-61.8	---	---	---	---	---	17	72	-63.5	---	---	---	---	---	5	74	-66.1	---
19,000.....	---	---	---	---	5	63	-64.6	---	---	---	---	---	---	---	---	---	14	61	-62.9	---	---	---	---	---	---	---	---	---
20,000.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8	52	-62.2	---	---	---	---	---	---	---	---	---

¹ Navy.

Observations taken about 4 a. m., 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels also the humidity data is not used in daily observations when the temperature is below -40° C.

TABLE 2.—Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during December 1938

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,564 m)		Atlanta, Ga. (302 m)		Billings, Mont. (1,095 m)		Boston, Mass. (15 m)		Brooklyn, N. Y. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (157 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (283 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Surface	341	1.4	317	1.6	245	4.2	264	2.1	297	3.2	279	5.1	254	2.1	253	0.9	252	2.1	298	1.8	30	0.9	45	3.1	98	0.4
500			305	2.0			287	6.4	306	6.0			259	3.8	242	3.3	255	4.5	308	3.9	175	2.2	70	4.6	31	0.2
1,000			290	4.0			300	7.9	301	7.8			268	6.4	257	8.0	260	6.3	303	6.5	260	4.0	106	2.5	135	1.9
1,500			279	6.0	267	8.3	304	10.8	288	8.8			269	8.6	258	9.8	275	8.5	292	8.0	261	6.7	232	0.8	164	4.9
2,000	299	2.3	274	8.2	282	10.6	299	11.6	280	10.6	283	7.3	268	10.3	268	9.5	289	9.5	294	10.5	275	7.4	255	2.0	166	3.6
2,500	293	6.2	277	10.4	294	10.7	290	11.9	280	13.5	293	13.2	271	12.3	272	9.7	293	10.5	294	10.1	278	8.7	268	2.9	174	4.3
3,000	291	8.7	290	11.3	295	11.2	282	13.1	279	14.5	300	12.3	271	13.6	276	9.1	305	6.7	282	7.7	271	8.5	253	3.5	168	3.7
4,000	290	11.4			310	7.2					300	11.8									302	10.3	242	4.3	98	4.1
5,000	289	12.6									282	10.9														

Altitude (meters) m. s. l.	Nashville, Tenn. (194 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha Nebr. (306 m)		Pear Harbor, T. H. (68 m) ¹		Pensacola, Fla. ¹ (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Surface	261	0.9	73	1.7	253	1.6	312	2.0			23	2.7	221	1.7	151	1.8	20	0.2	251	1.0	172	2.4	224	1.7	304	1.2
500	254	3.7	47	4.5	289	2.5	314	4.3			321	2.2	240	5.8			119	1.0	250	3.6	202	6.1			305	3.7
1,000	269	4.3	39	3.1	286	5.3	313	8.5			276	4.1	269	7.6			69	1.0	276	6.4	210	5.9	236	4.9	290	6.4
1,500	289	6.6	33	2.5	298	7.2	305	9.1			294	6.3	274	9.4	171	1.9	167	0.6	275	8.7	233	5.3	242	6.9	286	9.6
2,000	290	8.5	25	2.3	286	8.8	299	10.6			284	7.0	273	10.5	218	2.5	96	0.8			256	4.0	255	8.1	279	11.4
2,500	281	11.4	344	2.9	297	10.6	302	11.9			280	6.4	282	11.7	278	3.7	42	1.3			267	5.0	275	8.3	264	12.2
3,000	280	13.2	333	3.7	289	11.1	296	12.1			281	6.6	279	12.8	288	6.1	23	2.2			280	3.4	280	9.3	262	14.3
4,000	282	15.8	310	4.6	277	16.2	287	14.7			291	7.4	289	11.3	295	9.9	300	3.3			281	2.6	325	3.0		
5,000															274	11.4	323	3.5					345	11.3		

¹ Navy stations.

TABLE 3.—Maximum free-air wind velocities (m. p. s.), for different sections of the United States based on pilot-balloon observations during December 1938

Section	Surface to 2,500 meters (m. s. l.)				Between 2,500 and 5,000 meters (m. s. l.)				Above 5,000 meters (m. s. l.)						
	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station
Northeast ¹	42.6	WNW	2,360	12	Harrisburg, Pa.	42.0	W	2,860	31	Cleveland, Ohio	37.2	SW	6,110	5	Columbus, Ohio.
East-Central ²	38.5	NW	2,500	28	Richmond, Va.	45.0	W	5,000	28	Nashville, Tenn.	53.2	W	5,140	28	Nashville, Tenn.
Southeast ³	33.4	WSW	2,120	9	Tampa, Fla.	47.5	SW	3,540	9	Charleston, S. C.	43.6	WNW	9,840	2	Charleston, S. C.
North-Central ⁴	37.6	SSW	1,060	25	Minneapolis, Minn.	55.1	WNW	5,000	31	Fargo, N. Dak.	60.5	WNW	6,050	27	Fargo, N. Dak.
Central ⁵	34.4	W	2,080	31	Chicago, Ill.	50.0	NW	4,950	18	Springfield, Ill.	76.8	W	9,000	12	Wichita, Kans.
South-Central ⁶	36.6	WSW	2,500	26	New Orleans, La.	42.8	NNW	4,060	8	Amarillo, Tex.	68.0	WSW	9,810	23	Oklahoma City, Okla.
Northwest ⁷	42.8	WSW	2,160	2	Pendleton, Oreg.	50.0	NW	5,000	25	Pendleton, Oreg.	50.8	NW	5,040	25	Pendleton, Oreg.
West-Central ⁸	50.9	W	2,480	3	Cheyenne, Wyo.	48.0	W	2,670	3	Cheyenne, Wyo.	58.0	NW	9,240	8	Rock Springs, Wyo.
Southwest ⁹	32.4	N	1,930	1	Burbank, Calif.	54.1	SW	5,000	15	Winslow, Ariz.	78.8	N	10,120	7	Albuquerque, N. Mex.

¹ Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.² Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.³ South Carolina, Georgia, Florida, and Alabama.⁴ Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.⁵ Indiana, Illinois, Iowa, Nebraska, Kansas and Missouri.⁶ Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.⁷ Montana, Idaho, Washington, and Oregon.⁸ Wyoming, Colorado, Utah, northern Nevada, and northern California.⁹ Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.